# Multi-Layer Ceramic Fuel Cells BAA

"Low-Cost Manufacturing of Multi-Layer Ceramic Fuel Cells"

**Performer:**
NexTech Materials, Ltd.
Worthington, OH

**Contract:** DE-AC26-00NT40706

**PI:** Mr. William Dawson

**Funding:** $1.44M DOE
+ $0.42M Contractor Share
= $1.86M

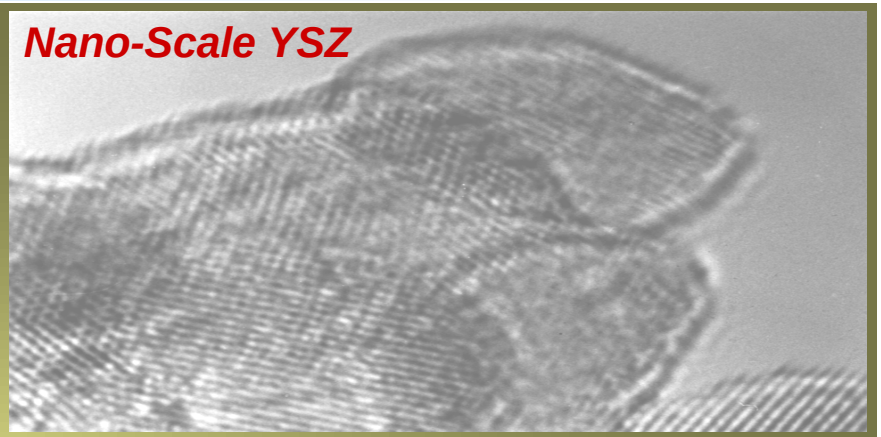
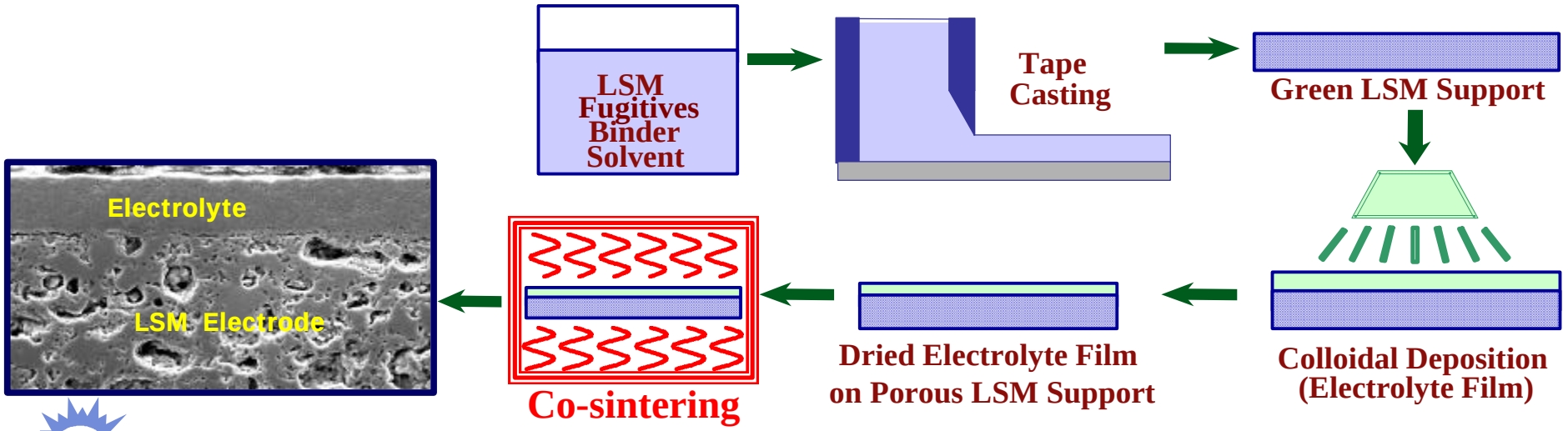



Image Courtesy of NexTech Materials Ltd.

**Sub-Contractors:** University of Missouri-Rolla, ORNL, Northwestern University, Edison Materials Technology Center, Michael Cobb & Associates, Adaptive Materials Inc., U.S. Air Force, Ohio State University, Institute of Gas Technology, Iowa State University, Advanced materials Technologies

# NexTech Project Description

- Develop multi-layer ceramics manufacturing processes similar to computer board and chip making
- Cost Study & Evaluation
- Small-scale development of manufacturing processes
- Non-destructive & Destructive evaluation Techniques
- Limited single stack testing
- Scale-up & Demonstrate Automated Manufacturing

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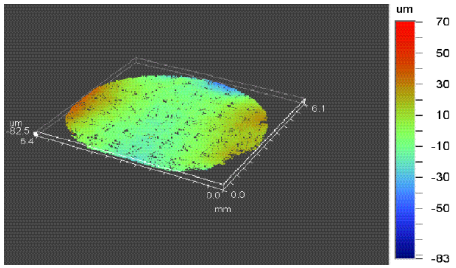
# NexTech Project Objectives & Milestones

- Producible SOFC designs with high power density and low cost
  - 1-2 kilowatts/liter and $100-125 per kilowatt
- Advance Destructive and Non-Destructive Evaluation Techniques
- Develop multi-layer ceramics manufacturing processes for fuel cells
  - Co-sintering of planar electrolyte elements
  - Spin-coating of ultra-thin film electrolytes

| | | 2000 | | | 2001 | | | | 2002 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Phase** | **Task** | **Q2** | **Q3** | **Q4** | **Q1** | **Q2** | **Q3** | **Q4** | **Q1** | **Q2** | **Q3** |
| I | Prelim. Design for Manufacture Analysis | | | | | | | | | | |
| II | Co-Sintering of Planar Electrode-Supported Elements | | | | | | | | | | |
| | Spin-Coating of Ultra-Thin Electrolytes | | | | | | | | | | |
| III | Test of Co-Sintered Electrode-Supported Elements | | | | | | | | | | |
| | Test of Spin-Coated Ultra-Thin Electrolytes | | | | | | | | | | |
| | Business Plan | | | | | | | | | | |

# NexTech Significant Accomplishments

- **Identified Multiple Approaches & Development Paths**
  - Cost & risk analysis on 5 planar concepts
  - Project $90 to $160/kW stack cost
- **Developed Numerous <u>Baseline</u> Process Modifications**
  - Tape casting of porous LSM (cathode) and NiO/YSZ (anode) substrates with controlled porosity and sintering shrinkage
  - Improved substrate flatness to ≤20 $\mu$m w/ optical profilometry
  - Screen printing processes for anode and cathode coatings
  - Dense and leak-tight YSZ electrolyte films
    - on LSM cathode substrates by spray-deposition and co-sintering
    - on NiO/YSZ anode substrates by screen printing and co-sintering
  - Increased process yield of nanoscale YSZ suspensions and achieved high solids content YSZ suspensions with particle size < 100 nm
  - Repeatable processes for continuous, crack-free PSMF/GDC cathode interlayer films, and ceria anode interlayer films

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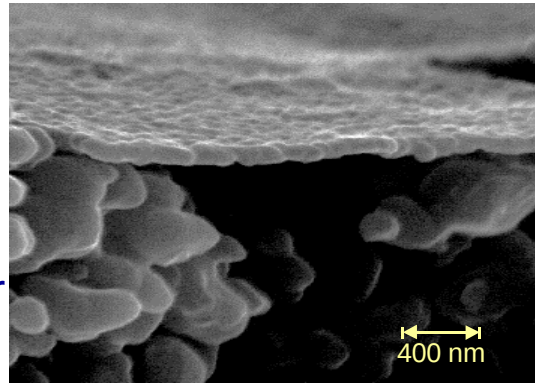
# NexTech Significant Accomplishments (cont)

- **Numerous <u>Alternative</u> Process Modifications**
  - Several tape casting methods for porous LSM cathode substrates
  - Colloidal method for planarizing LSM surface with nano-porous ceria coating to allow spin-coating of defect-free YSZ electrolyte films
  - Fabrication of dense, nano-crystalline YSZ films (2 $\mu$m thick) on porous LSM substrates w/ ceria-based interlayer
  - Increased conductivity of nano-porous ceria planarization layer by compositional modifications
  - Identified potential anode interlayer materials with extremely high electronic conductivity at low $pO_2$
- **Highly effective collaboration of large diverse team**
- **Now supplying new materials to SOFC developers and manufacturers**

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